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Degradation of Modified Sisal Fiber buried in Black cotton and litomargic soil

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Abstract*: The globe is facing numerous environmental challenges due to increasing in atmosphere and landfills pollution. The reason behind this problem is excusive dependence on artificial and manmade material. To overcome this problem there is need of effective utilization of natural, renewable, eco friendly material like plant or leaf fibers. But all the fibers from the natural sources are not ready to use in application directly they have to be alter according to requirement, without affecting their strength characteristic. Present trend is use of natural sisal fiber in soil stabilization, But Sisal fibers undergo degradation due to attack of microorganism. results in reduction in strength characteristic of natural fibers. This study focuses on modification of sisal fiber to avoid degradation of sisal fiber and also estimation rate of degradation by soil burial method. The sisal fiber is modified by chemical and physical treatment using NaOH and general purpose resign respectively. The non degraded known weight of sisal fiber without treated, sisal fiber treated with NaOH and sisal fiber treated with NaOH and resign is buried in black cotton soil (BC) and litomargic soil (LM) soil separately for period of 360 days in ambient atmosphere. Reduction in weight of buried sisal fiber due to degradation is determined at interval of 30 days the procedure is conducted for 360 days. The test results shows that the percentage degradation of sisal fiber without treatment is more in BC soil compare to LM soil. The degradation rate will be curtained by chemical modification using NaOH up to 40 to 50% in both the soil. And degradation rate is further reduced due to combined treatment with NaOH and resign application, the reduction is up to 50-60% in both the BC and LM soils. Hence by modification of sisal fiber by combined chemical and physical treatment we can effectively mitigate the degradation of sisal fiber buried in BC and LM soil.

***Index Terms*: Black cotton soil, Litomargic soil, Sisal fiber**

I. INTRODUCTION

The artificial fibers used as stabilizers in stabilization of poor soil are present practice. The use of artificial fiber directly indirectly effects on environment.

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The production of artificial fibers required large amount of burning fossil fuels for energy. The burning of fossil fuels emits pollutants to the environment which leads to high environment pollution. The dumping of residues from industries requires large area for disposal of waste, which effects on scarcity of agricultural lands. The use of manufactured artificial fiber in soil stabilization causes pollution of soil environment also. Hence, there is requirement of alternative fiber material for stabilization of poor soil. Utilizing environmental friendly natural fibers in stabilization of soil is reported [1-3]. But the problem associated with use of natural fibers in soil is degradation. The use of natural fiber directly in soil undergoes degradation process. The degradation of natural fibers directly effects on engineering behavior of fiber such as reduction in density, tensile strength and elongation character of natural fiber. The reduction in strength of natural fiber directly effects on strength behaviors of stabilized soil. Hence to mitigate this problem we have to modify the structure of natural fiber. By external and internal structural modification. We can effectively avoid degradation of natural fiber up to maximum extent. The degradation of natural fiber depends on soil type and its organic level and also it majorly affected by microbial activity of soil. Hence the there is a need of degradation analysis in term of different soil condition.

II. MATERIALS

A. Sisal fiber (SF): The natural fiber used in our work is procured form Hassan, Karnataka, India. Sisal fiber is extracted from sisal plant through ratting process.

B. Soil: The Black cotton soil used in our work for analysis of degradation of sisal fiber is procured form Hassan Karnataka, India. And Litomargic soil procured form Chickmagaluru, Karnataka, India. And it is collected by open excavation method from one meter depth.

III. MODIFICATION OF SISAL FIBER

The modification of sisal fiber is carried out by using different methods and materials. Chemical and physical modification took a vital role to avoid microbial activity on natural sisal fiber. The chemical modification of natural sisal fiber is carried out by rinsing the fiber with distilled water along with chemical agent such as Acetic Acid, KOH, NACL, NaOH and HCL etc. In research it is proved that the NaOH is most efficient chemical agent along with distill water to dissolve cellulose and hemicelluloses by braking hydrogen bond in network of structures [6]. The cellulose and hemicelluloses is the major structural components contain up to 65-70 and 12-20% respectively.

This structural component acts as feeds to the microbial and micro organism for their survival. Hence in sisal fiber presence of cellulose and hemicelluloses material in amour pose state results in more microbial activity on fiber material leads to degradation of fiber in higher rate [7]. The chemical treatment of sisal fibers using NaOH in particular percent breaks the hydrogen bonds between structural components cellulose and hemicelluloses [8]. And makes it in crystalline form which results in minimization of microbial activity on sisal fiber by microorganism, the degradation of sisal fiber is also mitigated. The physical treatment of sisal fiber is carried out by altering the external surface of fiber by applying the surface coating over sisal fiber using different material like Neem oil, bitumen, polyester and polyvinyl resigns [9] etc. From different study the use of polyester resign or general propose resign is more beneficial than any other material in term of application, handling and durability [10]. The physical treatment of sisal fiber using general purpose resign will act as barrier against microbial activity by minimizing moisture absorption (hydrophobic), which helps in mitigating degradation of sisal fiber up to certain extent. In practical application the use of chemical or physical modification alone is not beneficial against degradation. Hence the combination of both chemical and physical modification on sisal fiber will be beneficial [11].

A. Chemical Treatment:

The technique adopted is Mercerization or alkali treatment using Sodium hydroxide (NaOH), Following are the steps involved **Fig.1.**

1) The 10% NaOH solution by dissolving 4 grams of NaOH pellets in a 1000ml of distilled water.
2) The sisal fiber is rinsed in chemical solution for about One hour and washed with distilled water.
3) Sisal fibers are dried under sunlight till they are Completely dry and store for the next process.

B. Physical Treatment:

The chemical treated dried sisal fiber is coated with water resistant polyester resin [9]. The general purpose polyester resin is generously coated over the surface of sisal fibers and it is air dryed**Fig.2.**

Fig.1 Chemical treatment on Sisal Fiber

Fig.2 Physical Treatment on Sisal Fiber

IV. DEGRADATION TEST ON SISAL FIBER

The degradation of sisal fiber depends on many aspects like presence of microorganisms, amount of water available, surface area, availability of oxygen, degree of temperature, chemical environment, pH and electrolytes [4] etc. There are many methods to determine the degradation rate of sisal fiber, in that most familiar methods are Scanning electron microscope, Infrared spectroscopy, Soil burial method and M ermalgravimetric analysis etc. By research study we came to conclusion that the soil burial method of degradation test is most feasible and similar to practical condition [5]. But soil burial method of test requires more time and material source to analysis. The procedure for determination of degradation of sisal fiber by soil burial method discussed as follows

1) Categorize samples in three types. Non treated Sisal fiber, Sisal fiber treated with NaOH and sisal fiber treated with NaOH + resign**.** These set of 3 to 4gms sisal fiber samples are prepared and buried in both soil
2) Sisal fibers are buried in the particular soil at a depth of 5 cm and maintained approximately 20% moisture content throughout procedure for a period 360 days.
3) The buried samples were dug out at 30 days intervals, degraded sample were washed with water, dried in a vacuum oven at 50±1ºC for 24 h before evaluation.
4) The degraded samples were weighed to determine the weight loss. Equation 1.1 is used to determine the percentage weigh loss.

$$\mathbf{Wt} = \frac{W(o)-W(d)}{W(o)} x100 \qquad (1.1)$$

Here $w_{t\,is}$ degradation by percentage weight loss, w_d is the final weight after time t, w_o is the initial dry weight of the specimen before biodegradation [5].

V. RESULT AND DISCUSSION

A. Test Results of sisal fiber Buried in BC soil.

The rate of degradation of sisal fiber without treated, buried in BC soil is shown in graph1. Values are summarized in Table 1.

Table.1 Degradation Test Results of Sisal Fiber without Treatment Buried In BC Soil.

Degradation Test (Days)	Initial wt of sisal fiber w_o(gm)	Final wt of sisal fiber w_d(gm)	Degradation of sisal fiber without treatment w_t(%)
30	3.6143	3.5387	2.09
60	3.2947	3.1976	2.95
90	3.8371	3.7233	2.97
120	3.6849	3.5711	3.09
150	3.3056	3.1497	4.72
180	3.4382	3.1689	7.83
210	3.4353	3.1512	8.28
240	3.2014	2.9103	9.10
270	3.1562	2.8687	9.11
300	3.3067	2.9132	11.91
330	3.6244	3.1220	13.87
360	3.3231	2.8542	14.12

It is observe that rate of degradation for 360 day is up to 14.12% and it is 6.75 times than the initial rate of degradation. Sisal fiber treated with NaOH buried in BC soil is shown in graph1 and values are summarized in Table 2. The rate of degradation is about 7.07% and it is reduced to 50% compared to non-treated sisal fiber.

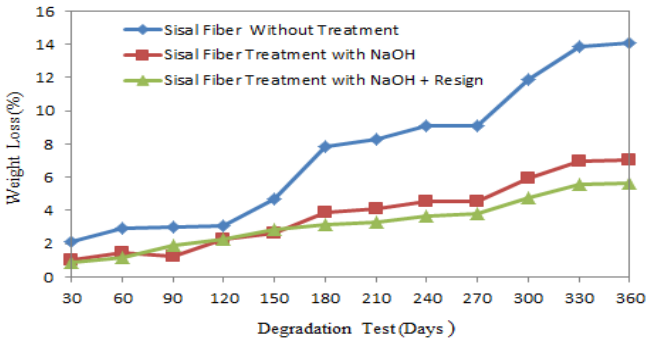
The degradation rate of sisal fiber treated with NaOH and resign, buried in BC soil is shown in graph1 and values are summarized in Table 3. The test results show that rate of degradation for 360 day is 5.65 % it is reduced up to 60% compared to non-treated sisal fibers. The degradation rate of sisal fiber buried in BC soil can be minimized up to 60% by combination of chemical and physical treatment.

Table.2 Degradation Test Results of Sisal Fiber treated with NaOH Buried In BC Soil.

Degradation Test (Days)	Initial wt of sisal fiber w_o (gm)	Final wt of sisal fiber w_d (gm)	Degradation of sisal fiber treated with NaOH w_t (%)
30	3.3502	3.3151	1.05
60	3.3375	3.2883	1.48
90	3.2434	3.2034	1.24
120	3.8321	3.7461	2.25
150	3.3045	3.2167	2.67
180	3.5563	3.4170	3.93
210	3.7519	3.5967	4.15
240	3.4947	3.3358	4.56
270	3.6185	3.4537	4.57
300	3.8000	3.5739	5.98
330	3.4346	3.1966	6.94
360	3.3527	3.1162	7.07

Table.3 Degradation Test Results of Sisal Fiber treated with NaOH + Resign Buried In BC Soil.

Degradation Test (Days)	Initial wt of sisal fiber w_o (gm)	Final wt of sisal fiber w_d (gm)	Degradation of sisal fiber treated with NaOH + Resign w_t (%)
30	3.5579	3.5281	0.85
60	3.4374	3.3969	1.17
90	3.5515	3.4838	1.92
120	3.328	3.2536	2.25
150	3.4082	3.3098	2.90
180	3.7669	3.6489	3.14
210	3.288	3.1792	3.32
240	3.642	3.5095	3.65
270	3.2886	3.1622	3.85
300	3.4475	3.2834	4.77
330	3.2573	3.0767	5.56
360	3.6045	3.4011	5.65



Graph.1 Rate of Sisal Fiber degradation buried in BC soil.

B. Test Results of sisal fiber Buried in LM soil.

Table.4 Degradation Test Results of Sisal Fiber without Treatment Buried In LM Soil.

Degradation Test (Days)	Initial wt of sisal fiber w_o (gm)	Final wt of sisal fiber w_d (gm)	Degradation of sisal fiber without treatment w_t (%)
30	3.5701	3.5378	0.91
60	3.6577	3.6168	1.13
90	3.7752	3.7065	1.83
120	3.8986	3.8142	2.17
150	3.7659	3.6880	2.08
180	3.3507	3.2412	3.28
210	3.5621	3.4317	3.67
240	3.6725	3.5042	4.59
270	3.9246	3.7268	5.05
300	3.7507	3.5071	6.51
330	3.0794	2.8555	7.28
360	3.7484	3.4208	8.75

Sisal without treated buried in LM soil is shown in graph 2 and values are summarized in Table 4. The rate of degradation is about 8.75% and it is 9.67 times than the initial rate of degradation. The rate of degradation of sisal fiber treated with NaOH, buried in LM soil is shown in graph 2 and values are summarized in Table 5. It is observed that rate of degradation for 360 day is up to 5.25% and reduced up to 40% compared to non-treated sisal fibers

The degradation rate of sisal fiber treated with NaOH and resign, buried in LM soil is shown in graph 2 and values are summarized in Table 6. The degradation test results shows for 360 day is 4.38 % it is reduced up to 50% compare to non-treated sisal fibers. The degradation rate of sisal fiber buried in LM soil can be minimized up to 50% by combination of chemical and physical treatment.

Table.5 Degradation Test Results of Sisal Fiber treated with NaOH Buried in LM Soil.

Degradation Test (Days)	Initial wt of sisal fiber w_o (gm)	Final wt of sisal fiber w_d (gm)	Degradation of sisal fiber treated with NaOH w_t (%)
30	3.7118	3.6917	0.55

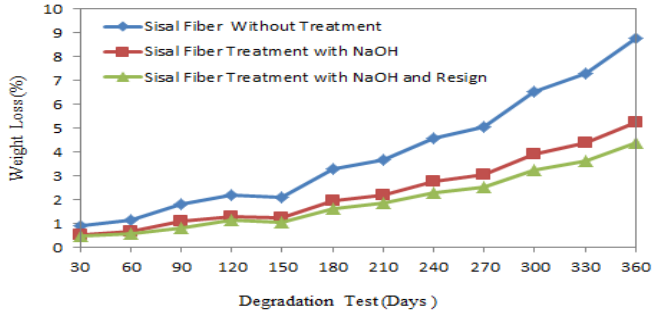
60	3.6018	3.5776	0.68
90	3.481	3.4430	1.10
120	3.712	3.6645	1.29
150	3.814	3.7667	1.25
180	3.1215	3.0603	1.97
210	3.2196	3.1489	2.21
240	3.1071	3.0217	2.76
270	3.9881	3.8675	3.04
300	3.4285	3.2949	3.91
330	3.5143	3.3610	4.36
360	3.4838	3.3011	5.25

Table.6 Degradation Test Results of Sisal Fiber treated with NaOH + Resign Buried in LM Soil.

Degradation Test (Days)	Initial wt of sisal fiber w_o (gm)	Final wt of sisal fiber w_d (gm)	Degradation of sisal fiber treated with NaOH + Resign w_t (%)
30	3.9427	3.9249	0.46
60	3.4129	3.3938	0.57
90	3.5379	3.5093	0.82
120	3.7482	3.7058	1.14
150	3.944	3.9032	1.04
180	3.4005	3.3449	1.64
210	3.3916	3.3295	1.84
240	3.9431	3.8527	2.29
270	3.8461	3.7492	2.53
300	3.6102	3.4930	3.25
330	3.8861	3.7448	3.65
360	3.6322	3.4735	4.38

The degradation rate of non-treated sisal fiber buried in BC soil is more compared to non-treated sisal fiber buried in LM soil. Sisal fiber treated with NaOH buried in BC, LM soil, the degradation rate is more in BC soil. Similarly sisal fiber with combined NaOH and resign treatment buried in BC and LM the degradation rate is more in BC soil only.

The results shows that the degradation of sisal fiber is more in BC soil compare to LM soil either the fiber is treated or non-treated. But in comparison physical treated sisal fiber is capable of reducing microbial activity on sisal fiber up to 40-50% in both the soil. The combination of both physical and chemical is still more enhances the efficiency of fiber against microbial activity on sisal fiber and it is capable of reducing 50-60% degradation of sisal fiber buried in BC and LM soil respectively.



Graph. 2 Rate of Sisal Fiber degradation buried in LM soil.

VI. CONCLUSION

The degradation rate is more in BC soil compared to LM soil due to the reason the microbial activity is more in organic and moist soil like Black Cotton Soils than the inorganic Litomargic soils. The physical and chemical modification of sisal fiber using NaOH and general purpose resign is beneficial to minimize microbial activity on natural sisal fiber. Hence we can mitigate degradation of sisal fiber effectively. The combination of both physical and chemical treatment is essential to achieve higher efficiency in respect of minimizing degradation of natural sisal fiber.

REFERENCES

1. S. Muthu Lakshmi, S. Sasikala," Utilization of Coconut Coir Fibre For Improving Subgrade Strength Characteristics Of Clayey Sand" (IRJET) Vol: 05, Issue: 04, Apr-2018, pp: 2873.
2. Shrithi S Badami," Stabilisation of Black Cotton Soil by Random Inclusion of Sisal Fibre" Vol. 6, Issue 2, Feb 2017,pp-1535.
3. Kiran.S.P, Dr. A.N Ramakrishna" Analysis The Strength Of Bc Soil Stabilized Using Cement\Rice Husk Ash\Sisal Fiber" International Conference on Soil and Environment, ICSE 2016, Bangalore.
4. Khubaib Arshad, Mikael Skrifvars "Biodegradation of Natural Textile Materials in Soil" DOI: 10.14502/Tekstilec2014.57.pp118–132.
5. Kh. Mumtahenah Siddiquee, Dr. Md. Maksud Helali," Investigation of an Optimum Method of Biodegradation Process for Jute Polymer Composites" (AJER), Vol-03, Issue-01, pp:200-206.
6. Rakesh Kumar, Sangeeta Obrai," Chemical modifications of natural fiber for composite material" Pelagia Research Library 2011, vol:2, issue:4,pp:219-228
7. I.O. Oladele, J.A. Omotoyinbo" Investigating the Effect of Chemical Treatment on the Constituents and Tensile Properties of Sisal Fibre" jmmce.org, 2010, Vol. 9, No.6, pp:569-582.
8. A.I.S. Brígida a, V.M.A. Calado b," Effect of chemical treatments on properties of green coconut fiber" Carbohydrate Polymers, 2010, vol: 79, pp: 832–838.
9. Fauziah Ahmad, Farshid Bateni," Application of Thermoplastics in Protection of Natural Fibres" www.intechopen.com,Universiti Sains Malaysia (2012).pp:329-346
10. Lili Li1, Margaret Frey, Kristie J Browning" Biodegradability Study on Cotton and Polyester Fabrics" Journal of Engineered Fibers and Fabrics – 2010, Vol: 5, Issue: 4 ,pp:42-52
11. Neena Gautam1, Inderjeet Kaur," Soil burial biodegradation studies of starch grafted polyethylene and identification of Rhizobium meliloti therefrom" Journal of Environmental Chemistry and Ecotoxicology.2013, Vol: 5,issue:6, pp:147-158.

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